Overlapping cardiac volume reduction operation

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Partial left ventriculectomy (PLV) has been introduced to treat end-stage cardiomyopathy but has not achieved a favorable outcome. We thought it important to preserve cardiac muscle possessing the potential power source of the left ventricle and to avoid resection of the left circumflex coronary artery. From this viewpoint, we developed a new operative procedure of left ventricular (LV) volume reduction without any resection of cardiac muscle and have confirmed its beneficial effect in a canine model. This is the first clinical report of this new procedure.

Clinical Summary

A 62-year-old man with dilated cardiomyopathy (DCM) was referred to our institution in August 2001. Since 1995, he has been treated with medication, including β-blockers, for DCM with mild mitral and aortic regurgitation confirmed by endocardial biopsy. However, he had orthopnea (New York Heart Association class III) in May 2001, when echocardiography demonstrated an ejection fraction (EF) of 23% with severe mitral and moderate aortic and tricuspid regurgitation. In July 2001, he required direct-current shock to be resuscitated from an arrhythmia. Preoperative catheter laboratory study showed mean pulmonary wedge pressure of 12 mm Hg, LV end-diastolic pressure of 18 mm Hg, cardiac index of 1.86 $L \cdot min^{-1} \cdot m^{-2}$, LV end-diastolic volume of 182 mL, LV end-systolic volume of 137 mL, EF of 24%, and intact coronary arteries.

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The operation was performed on August 4. Informed consent was obtained before the operation. The operative procedure included replacement of the thickened aortic valve with myxoid change with a 21 Carpentier-Edwards pericardial valve, annuloplasty of a simply dilated mitral anulus with a 26 Carpentier Physioring, tricuspid annuloplasty with a 30 Cosgrove ring (Baxter Healthcare Corporation, Irvine, Calf), and our original LV reduction operation, termed overlapping cardiac volume reduction operation (OLCVR). OLCVR consisted of the following 3 steps: (1) a transmural longitudinal incision along the left anterior descending artery in the enlarged LV free wall; (2) continuous sutures of the left incision marginal to the endocardium of the septal wall; and (3) interrupted sutures of the right incision marginal to the ventricular free wall (Figures 1 and 2). It took about 30 minutes to complete the OLCVR procedure. Cardiopulmonary bypass was conducted under mild hypothermia with antegrade and retrograde intermittent cold blood cardioplegia. Weaning from cardiopulmonary bypass was easy after a 121-minute crossclamping period.

Results

The patient recovered uneventfully and was extubated 4 hours after the operation. Two weeks' postoperative catheter study showed mean pulmonary wedge pressure of 7 mm Hg, cardiac index of 2.93 $L \cdot min^{-1} \cdot m^{-2}$, LV end-diastolic volume of 141 mL, LV end-systolic volume of 87 mL, and EF of 38% without damage to coronary arteries. He was discharged 26 days after the operation and has been doing well in New York Heart Association class I for 7 months without any troublesome arrhythmias.

Discussion

The primary objective of PLV is to decrease LV wall tension on the basis of Laplace's law[1] under the premise that remaining cardiac muscle is viable. However, prediction of the viability of cardiac muscle is often difficult, and PLV would worsen LV function if the resected area included the most viable muscles.[2] Another problem is that PLV is associated with the resection of the obtuse marginal circumflex coronary artery, which might lead to myocardial ischemia, causing postoperative arrhythmia.[4] Recent series of PLV have shown a high operative mortality, high incidence of recurrence of heart failure, and arrhythmia-related deaths.[3]

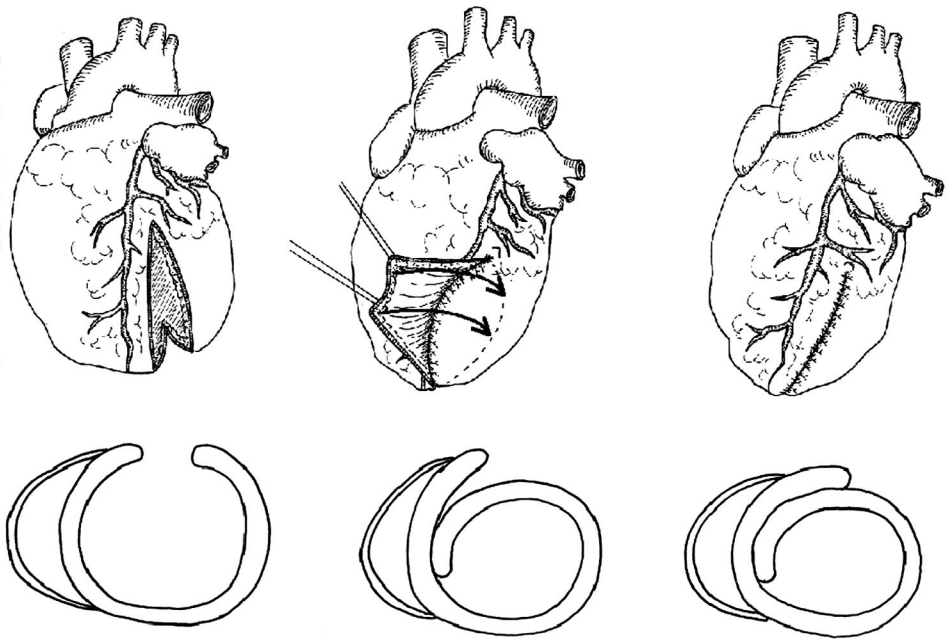

Figure 1. Operative procedures of OLCVR. *Left,* A transmural longitudinal incision along with the left anterior descending branch in the enlarged LV free wall. *Middle,* Continuous sutures of the left incision marginal to the endocardium of the septal wall. *Right,* Interrupted sutures of the right incision marginal to the LV free wall.

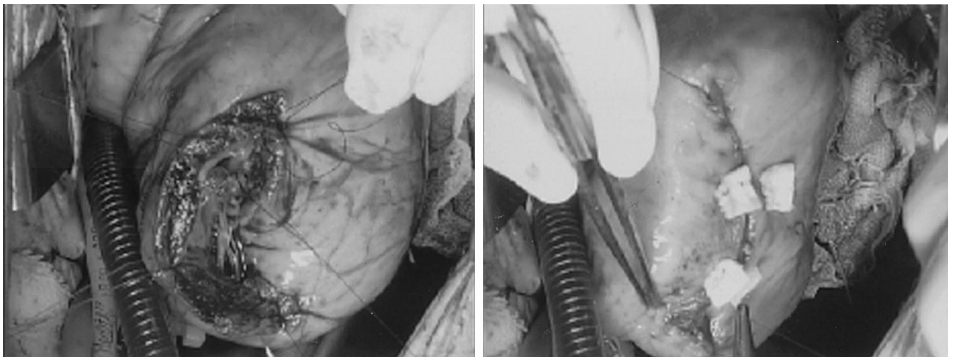

Figure 2. Intraoperative view of OLCVR. *Left,* Continuous sutures of the left incision marginal to the septal wall. *Right,* Pledget-supported mattress sutures of the right incision marginal which vessels were cauterized electrically to the LV free wall.

Our new procedure, OLCVR, has a couple of merits when compared with the traditional PLV, namely preservation of cardiac muscle and preservation of the circumflex coronary artery. These merits might be better suited to preserve LV contractility and to avoid LV ischemia than PLV, which might lead to a better outcome. The other presumable merits might include that (1) OLCVR might be a reversible procedure when the overlapping portion is too excessive; (2) the overlapping portion of cardiac muscle might have a girdling effect in the long-term period, as well as during cardiomyoplasty[4]; and (3) the excluded portion (a part of septum and anterior muscle) does not undergo direct pressure from the inside of the heart and therefore might possess a potential ability to support cardiac function, as well as cardiomyoplasty with the latissimus dorsi.[5]

Because we performed aortic, mitral, and tricuspid valve surgery in addition to OLCVR, the drastic improvement of the patient's condition might not result from OLCVR only. However, mitral reconstruction would be beneficial for patients with DCM and viable myocardium but without severely deteriorated LV function.[1] According to preoperative deteriorated LV functions, OLCVR must be beneficial for the rapid recovery of cardiac function and might save medical expenses in our case. Although long-term follow-up is mandatory, OLCVR might become a therapeutic option for end-stage cardiomyopathy.

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